ANNULAR REPAIR

STABILITY OF A MECHANICAL BARRIER USED TO SEAL ANNULAR DEFECTS

Mr. Jacob Einhorn
Woburn, MA, USA
Co-authors: Oscar Yeh; Emir Kamaric; Samuel Chow; Maurice Small; Greg Lambrecht

Recurrent herniation following discectomy has been reported in up to 23% of patients. Extrusion of different types of prosthetic nuclei has been reported in both cadaveric (20%) and clinical (38%) studies. Closing annular defects with a mechanical barrier may reduce the incidence of such reherniations and extrusions. However, migration, expulsion, or gross fracture of such a barrier in vivo, where intradiscal pressures up to 330 psi have been reported, must be addressed.

A scalpel (n=10) or custom tool (n=4) was used to create ~5x5 mm posterolateral box anulotomies in 14 FSUs, simulating a standard discectomy approach. Custom tools were used to create 5x10 (n=20) or 4x10 (n=4) mm defects in 24 FSUs, simulating worst-case defects. Barriers were implanted between the anulus and nucleus. A custom test fixture was used to apply 100 cycles each of flexion/extension, R/L lateral bending, and flexion/extension over each foot (10Nm at 0.25Hz). Following cyclic testing, the FSUs were oriented to replicate an in vivo herniation by combining flexion and lateral bending while applying non-constraining, compressive loads until one of the following events occurred: Failure of the FSU, or plateaued intradiscal pressure with increased loading.

Fluoroscopy confirmed that there was no gross movement, expulsion, or fracture of any of the implants. During flexion-compression loading, 17 FSUs failed by endplate or vertebral body fracture and achieved peak intradiscal pressures (265±74 psi) which were signifcantly lower than pressures achieved in the remaining specimens ($p<0.0001$, t-test). The remaining FSUs exhibited peak pressures of 388±62 psi (544 psi max). These pressures were greater than the highest reported in vivo value of 330 psi, indicating that our test protocol was aggressive. Without flexion, such high intradiscal pressures could not be reached, probably due to higher facet loading. CT analysis confirmed that mechanical testing did not appreciably alter barrier orientation.

The results demonstrate that a mechanical barrier used to seal annular defects can be stable and maintain its integrity when subjected to complex, physiologic loads. Such a barrier may be safe and stable in sealing annular defects, and is being studied as a method of reducing recurrent herniations and retaining nucleus prosthetics.

DISC COLLAPSE FOLLOWING DISCECTOMY USING A NOVEL APPROACH TO MEASURE INTERVERTEBRAL DISC HEIGHT

Mr. Emir Kamaric
Woburn, MA, USA
Co-authors: Oscar Yeh; Almir Velagic; Gamal Osman; Jacob Einhorn; Milorad Vilandecic; Greg Lambrecht

Disc height loss is an important clinical measure that has been associated with increased lower back pain. A long-term study of discectomy patients found that those who lost a significant degree of disc height, defined by the investigators as greater than 25%, had significantly lower clinical outcome scores (JOA scores). Through a prospective clinical study, we sought to investigate the time course of disc height loss and/or recovery following discectomy.

It is generally accepted that there are errors involved with making precise measurements from 2D radiographs. This lack of repeatability makes it difficult to perform serial studies of disc height. CT reconstructions can address these inaccuracies by providing a complete 3D description of the inter-vertebral (IV) space. We used this 3D data to calculate the total volume of the IV space and then divided the volume by the cross-sectional area of the IV space. The result was an effective disc height that is essentially the average of all disc heights within the transverse plane of the disc. CT scans of 20 discectomy patients were obtained pre-operatively, and at 6 weeks, 3 months, 6 months, and 9 months post-operatively.

Accuracy of our CT based disc height measurement was verified using a cadaveric spine. Scans were obtained oblique to the endplate. The maximum distance between transverse processes at each level from L1 to L4 was calculated and then compared with physical caliper measurements. Average error in all measurements of the cadaveric spine was less than 0.5%. Patients undergoing discectomy lost disc height following surgery. The average pre-operative disc height was 6.16 (SD 1.95) mm. An initial collapse of approximately 20% occurred within the initial 6 weeks. By 9 months, nearly 40% of the pre-operative disc height was lost.

A significant amount of disc height loss was observed within only 9 months of discectomy surgery. As studies have associated disc